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ON THE EFFECT OF SOLAR ACTIVITY ON PROCESSES IN THE EARTH'S LOWER ATMOSPHERE

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SUMMARY

Analysis of baric maps (altitude higher than 5 000 meters) of the Northern Hemisphere for the years 1949 to 1962 has shown, that the areas of greater recurrence of maximum and minimum pressure at upper troposphere and lower stratosphere heights are concentrated in the annular zones, similar to those of aurorae. The number of these baric formations has two maxima in the 11-year cycle, coinciding with the corresponding maxima in the glow intensity of the coronal line λ 5 303 Å. Therefore, both, the geographical distribution of altitude baric formations and their variations in time, suggest that they are determined by solar corpuscular radiation.

* * *

1. - INTRODUCTION. - The development of active processes in the Sun is attended by emission of intense ultraviolet radiation, of corpuscular streams and by radio emission. These radiations, reaching the Earth's atmosphere, induce in it strong variations, which are particularly evident in the upper atmosphere layers at heights above 60 — 70 km.

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* O VLIYANII SOLNECHNOY AKTIVNOSTI NA PROTSESSY B NIZHNEY ATMOSFERE ZEMLI.

The effect of active solar radiations on the lower layers of the atmosphere (troposphere, stratosphere, ozonosphere) is less evident. A large number of publications on this subject, of which the list has been recently compiled in monographs [1, 2], containing mostly statistical comparisons of indices of solar and troposphere activities, led to results poorly agreeing among themselves. Because of that, the very idea on the possibility of solar activity effect on the troposphere became undermined, and this incited a series of researchers to consider the lower layers of the Earth's atmosphere as a closed system. In our opinion, the causes of these failures are :

1.- The inclination to find universal, monotypic links in various geographic regions of the terrestrial globe, without taking into account the great complexity in the development of tropospheric processes, strongly dependent upon the properties of the underlying surface, of the season, the time of the day and the geographical position and initial conditions. This leads us to estimate that the action of solar activity on the terrestrial atmosphere will be ambiguous at various places.

2.- The usually employed indices of solar activity of easier access such as the sunspot areas and the Wolf numbers, are nonlinearly connected with the values of the solar radiation, which has significance for the processes in the lower layers of the Earth's atmosphere.

It follows from the above-said, that when characterizing the troposphere disturbances, one can not be limited by observations at a single point, even if of several years' standing, but must view the meteorological processes in a planetary scale.

Expounded below are the basic results and conclusions of two works [1, 3], which allow to approach the problem "Sun-troposphere", to understand the causes of failure of numerous works and to show, that powerful cyclones and anticyclones are conditioned by solar corpuscular streams, in the stratosphere, whether in space or in time.

2. - Spatial Distribution of Powerful Baric Centers within the Stratosphere

It was noted a long time ago that the regions, where powerful baric formations occur: cyclones and anticyclones (i.e. formations that are observed in the upper troposphere and lower stratosphere in the 5—15 km altitude range and determine the main peculiarities of the general atmosphere circulation), are not distributed at random along the Northern Hemisphere. Altitude anticyclones appear mostly over the western boundaries of Asia and North America, while altitude cyclones are mostly over the eastern shores of the continents.

B. I. Sazonov [1] analyzed 12 000 altitude baric charts of the Northern Hemisphere for the years 1949 through 1962, with the view of outlining the regions of most frequent recurrence of extremal deflections of pressure from the normal. It was found that the regions of the greatest recurrence of maximum pressure form annular zones, analogous to those of the aurorae. We brought out, as an example, in Fig. 1 the recurrence in percent of maximum pressure in the stratosphere in winter. It is clearly seen that such zone forms a ring, whose center is near the geomagnetic pole. This pattern, clearly expressed in the stratosphere, becomes rapidly blurred at transition to the middle and lower troposphere. Fig. 1 was borrowed from the indicated work [1], in which a series of analogous charts, drawn from broad observational material, is brought up, and a description of the method applied in the work is given. An analogous annular zone is obtained also for the extremely low values of pressure. This zone is somewhat displaced to the west relative to the zone of extremely high pressures. It is shown, that at passing of great sunspot groups through the central meridian of the Sun, an increase of pressure takes place in the baric formations of the first zone, and a drop in the second one.

These results clearly point to the fact, that the agent, stimulating the development of baric formations in the stratosphere and upper troposphere, is the solar corpuscular radiation, whose distribution is

determined by the Earth's magnetic field. Hence, it follows also, that the reaction of the lower atmosphere on solar activity will have either sign, depending upon the region considered. This region will be sharply outlined in the upper troposphere and stratosphere, and its geographical position will be unsteady and not clearly expressed in the troposphere, as a result of the washing out of both zones near the terrestrial surface. This is a normal result of the effects of thermal, mechanical and radiative peculiarities of the underlying surface. It explains the absence on the Earth's surface of spots with steady, clearly expressed indications of a link between meteorological and solar indices. Such links can be only casually observed over the extent of several 11-year cycles, using terrestrial data.

3.- Manifestation of the 11-year Cycle of Solar Activity in Meteorological Phenomena

When comparing the variations in the troposphere with those of solar activity, attempts were made in detecting in troposphere indices the 11-year cycle, analogously to that observable in the activity of sunspot formation. Whereas such links were found in some 11-year cycles, they were not confirmed in the others. More often two maxima were observed in numerous meteorological indices in the course of an 11-year cycle, fact which many considered as an indication of the absence of such links. In the monograph by B. M. Rubashev [2], a compilation of numerous works is made on pages 276 — 278, in which the existence during an 11-year cycle of two waves in the tropospheric processes is indicated.

Two maxima in the course of an 11-year cycle are also noted in the indices characterizing the circulation in the planetary scale. In particular two maxima are also observed in the recurrence of powerful baric formations considered in the preceding part 2. The middle curve of Fig. 2, borrowed from [1], shows the number of cases, when extremely powerful altitude baric formations were observed for each winter from 1949 to 1962.

The upper curve of Fig. 2 shows how the suspot area varied in the current 11-year cycle. It is seen that while the sunspot area curve has

one maximum in 1957, a second maximum, besides that of 1957, is observed also at the divide between 1959 and 1960 at the curve of number of cases of extremely powerful baric formations. This second maximum was about the same magnitude as the preceding one. The explanation of the appearance of that second maximum is given in the work by Gnevyshev [3].

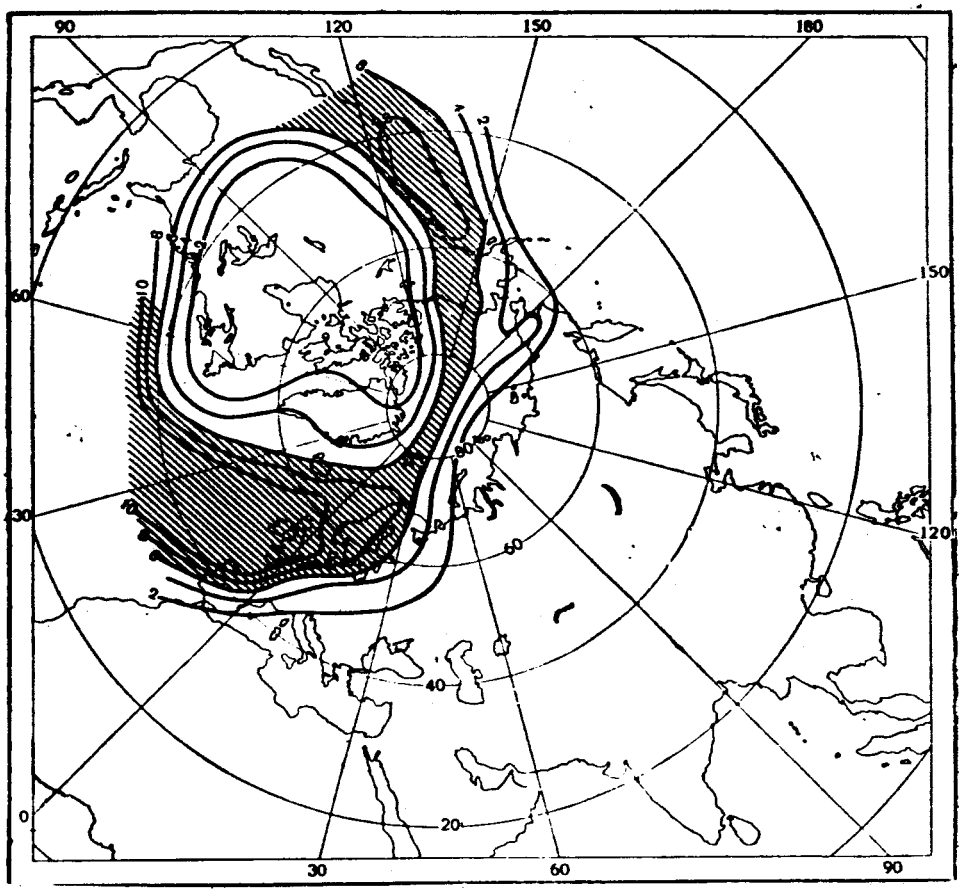

Fig. 1.- Recurrence of appearances in wintertime of extremely high values of pressure in the lower startosphere for the years 1949 — 1962. The numerals near isolines are the conventional units of recurrence. The zone of greater recurrence is shaded.

Consideration of the results of observations of the solar corona outside eclipses (see [3]) has shown, that the intensity of coronal lines (lower curve, Fig. 2) has two maxima in the 11-year cycle, which are both of identical magnitude. The first approximately coincides in time

and by the heliographic position with the maximum in the sunspot formation activity, and the second is observed three years later, i.e. at the same time as the second maximum on the curve for the number of extremely powerful formations. Since it may be assumed that the corona intensity is proportional to the energy, the frequency and density of corpuscular streams passing through it, it is obvious that the effects, induced by them in the lower atmosphere of the Earth must follow the variations in the intensity of coronal lines. The above-said is corroborated by the similarity of the median and lower curves of Fig. 2.

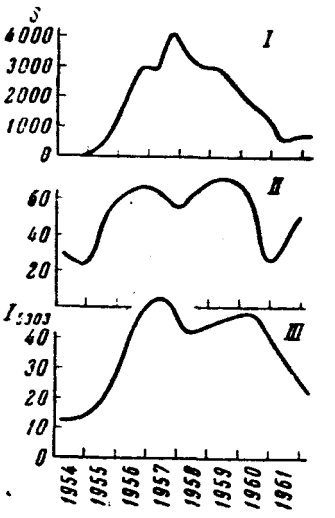

Fig. 2.- Comparison of areas of sunspots in millionths fractions of Sun's hemisphere (I), number of cases of extremely powerful formations in the upper troposphere and stratosphere, (II) and intensity of the coronal line 5 303 A in standard units (III) in the 11-year cycle.- The years are in abscissa.

It was shown in [3] that the periods of greatest brightness of the solar corona coincide in time with the fastest drop of sunspot formation activity. This explains the absence of analogy between the upper and the median curves of Fig. 2.

It is interesting that two maxima are also observed in comet visibility in the course of the 11-year cycle* The first one coincides in time with the maximum of sunspot formation activity, and the second's onset comes several years later. Comparison of brightness flares of comets with geomagnetic disturbances has shown, that even in that case the solar agent is the corpuscular radiation.

Therefore, the presence of a second maximum in the indices of tropospheric activity in the 11-year cycle, became an important argument in favor of proving the conditionality of tropospheric processes by the solar activity.

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* as was shown by Dobrovol'skiy [4].

In this connection the numerous facts of presence of two-summit patterns in the 11-year cycle, which were revealed in the run-off of Syr-Dar'ya and Amu-Dar'ya rivers, and, by way of consequence in the level of the Aralian sea, in that of the Lake Victoria, in thicknesses of ribbon marls, silts and clays. According to geologic data, the dual wave in the 11-year cycle, having received the designation of the 5-6 year cyclicity, can be traced over millions of years.

The time interval, noted in the current cycle between two maxima of coronal intensity and the geophysical events connected with it, is equal to three years in the present cycle, but may have another value in other ones.

4. - CONCLUSION

The results, expounded in the preceding two parts, show that processes in the upper troposphere and lower stratosphere are conditioned by solar activity, both, from the standpoint of their geographical distribution and their variation in time. At the same time, everything speaks in favor of the fact, that the agent, perturbing the lower layers of the Earth's atmosphere, is the corpuscular radiation.

While expounding these results we did not indulge in any detailed description of the method of work and material utilized, since all this is described at length in [1] and [3], but we concentrated our attention on the principle aspects of the question. Works [1, 3] show, in particular, that in case of tropospheric processes, indices of spot formation activity cannot be utilized for comparisons, for they characterize the intensity of ultraviolet radiation. This follows from the close correlation of ionosphere characteristics with spot areas and Wolf numbers.

The results described here point to the great value of coronal data as characteristics of Sun's corpuscular radiation.

**** THE END ****

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